

Appendix B

Input Variable Descriptions and Calculations

OEP, with help and input from DES, DAS, and DOT suggests the following figures for the Cost of Ownership Vehicle Selection Calculator:

1. Vehicle Description:

The make and model of the vehicle.

2. Purchase Price:

The state fleet manager provides a price as part of the Approved Vehicle Index, which is built from a set contract with specific vendor(s).

3. Fuel Cost/Unit:

The price of fuel per unit. These are calculated specifically for state fuel rates:

Electric rate: \$.1252/kWh

Electric Rate:

This figure projects a .6% increase from the most recent annual (fiscal year) state contract price (\$.1212) over a 10 year vehicle lifespan. The Energy Information Administration (EIA) lists a wide range of possible real price increases based on a number of complex factors. The reference case is an estimated real price increase of 18% (.667% annually) between 2013 and 2040. To calculate the average annual fuel price for electricity, OEP takes the average price over 10 years given a .667% annual price increase. The electric rate does not include any infrastructure maintenance costs.

Calculations:

State Electric Rate 3.6% increase 10 years			
2016	0.1212	2022	0.12613
2017	0.12201	2023	0.12697
2018	0.12282	2024	0.12782
2019	0.12364	2025	0.12867
2020	0.12447	2026	0.12953
2021	0.12530	10 yr. Average	0.125232

Sources:

EPA price forecasts for electricity:

https://www.eia.gov/forecasts/aeo/section_prices.cfm

**State of New Hampshire
Cost of Ownership Calculator**

[http://www.eia.gov/forecasts/aeo/data/browser/#/?id=3-AEO2016®ion=1-0&cases=ref2016~ref_no_cpp&start=2014&end=2024&f=A&linechart=~~~~~
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State electrical rate provided by Department of Administrative Services Energy Manager and Energy Database Analyst.

Gasoline Rate:

State vehicles largely purchase gasoline through state run facilities due to a state mandate. The rate paid at a state pump includes markups from both the vendor and the DOT for administrative costs, infrastructure and transportation. Prices vary depending on the location of the filling station, with stations further from ports where fuel is imported having higher markups for transportation. This figure takes the average annual(fiscal year) DOT pump price paid per gallon by state vehicles (\$ 2.71) and adds a .407% annual price increase rate over a 10 year time span. The EIA long-term gasoline price predictions range from an 84% increase to a 26% price decrease which indicates a high level of uncertainty in future gasoline prices. The reference case listed by EIA, which represents the middle estimate, predicts an 11% real price increase in gasoline prices between 2013 and 2040 (a .407% annual increase). We then take an average price from the ten years of real annual prices. The state gasoline rate includes a \$.15/gallon charge which covers some, but not all, infrastructure and administrative costs.

Calculations:

State Gasoline Rate	
2016 price + .055%/yr	
2016	2.71
2017	2.721
2018	2.732
2019	2.743
2020	2.754
2021	2.766
2022	2.777
2023	2.788
2024	2.800
2025	2.811
2026	2.822
ten year average	2.765

Sources:

EIA long term predictions for gasoline:

https://www.eia.gov/forecasts/aeo/section_prices.cfm

http://www.eia.gov/forecasts/aeo/data/browser/#/?id=3-AEO2016®ion=1-0&cases=ref2016~ref_no_cpp&start=2014&end=2024&f=A&linechart=~~~~~ref_no_cpp-d032316a.28-3-AEO2016.1-0~ref2016-d032416a.28-3-AEO2016.1-0&map=ref_no_cpp-d032316a.3-3-AEO2016.1-0&ctype=linechart&sourcekey=0

4. Emissions per unit:

The emissions per unit only accounts for the emissions caused by the use of fuels once the vehicle is purchased. This is not a life cycle analysis which accounts for the emissions used to create the vehicle. The staff partnership feels that kind of accounting is beyond the scope of the state's authority as well as more difficult to research. While emissions figures for fuels are well established and available, life-cycle emissions figures for each model vehicle the state purchases would be prohibitively difficult to collect and may not exist in any standard format.

Electricity (MTCO₂/kWh): .000315

Electricity Emissions/unit

The metric tons of emissions/kWh of electricity is calculated from the lbs/MWh reported to the PUC by Direct Energy, the supply service company which currently holds the NH State electrical supply contract.

Calculations:

Direct Energy Electric Mix CO ₂ Emissions	
695.351	lbs/MWh
0.315406	metric tons/MWh
0.000315	metric tons /kWh

Sources:

PUC Emissions Report for Direct Energy:

<http://www.puc.state.nh.us/Consumer/EDLabels/Direct%20Energy%20Business%20Marketing%20Disclosure%20label%202015.pdf>

Gasoline (MTCO₂/gallon): .001035

From the EIA Frequently Asked Questions response figure for E10 (a combination of 10% ethanol and 90% gasoline) which makes up the primary gas mixture sold in the US. DOT confirmed state gasoline supplies are 10% ethanol.

Calculations:

Gasoline emissions/gallon

Given	18.95	lb/mmbtu
	1 gal gas	125000 btu
Calculations	18.95	lb/mmbtu
	0.00001895	lb/btu
	2.36875	lbs/gal
Total	0.00103495	metric tons/gal

Sources:

EIA: <http://www.eia.gov/tools/faqs/faq.cfm?id=307&t=11>

EIA: http://www.eia.gov/energyexplained/index.cfm?page=about_energy_units

5. Total Lifetime Miles:

Assumed 150,000 as recommended (current practice) by fleet manager.

6. Fuel Economy:

EPA figures for city, highway, or combined:

Gasoline Fuel Economy

Combined highway/city miles/gallon

Sources:

US Government (US DOE, US EPA) Fuel Economy Source: www.fueleconomy.gov

Electric Fuel Economy

Fuel economy for electric vehicles is displayed by EPA through either MPGe (mile per gallon equivalents) or kWh/100mi. Because we are using kWh as the unit of measurement our calculation divided kWh/100mi to arrive at kWh/mi. At 31 kWh/100mi that means a vehicle consumes .31kWh per mile. The suggested figure is the combined fuel economy for the 2016 EV Focus.

Calculations:

32kWh/100mi = .32 kWh/mi

Sources:

US Government (US DOE, US EPA) Fuel Economy Source: www.fueleconomy.gov

7. Maintenance and Repair:

Figures provided by ARI, global fleet management company and recommended by NH State Fleet Manager. The \$.052/ ARI gasoline maintenance figure aligns closely with the state's average which is \$.05/mi. The state has no records for electric vehicle maintenance.

8. Cost of carbon:

EPA Social Cost of Carbon at 3% discount rate: \$36.

Assuming a discount rate of 3%; EPA estimates that every metric ton of CO₂ in the atmosphere will cost \$36 for 2016 and \$38.40 for 2017. The DOE's cost of carbon was [recently upheld](#) in federal court. See SGEC Memo for more information.

Sources:

EPA: <https://www3.epa.gov/climatechange/EPAactivities/economics/scc.html>

9. Sensitivity Analysis:

This graph allows viewers to see how changes in different variables impact the overall cost of ownership of a vehicle. The graph plots a change in overall cost caused by a change to each variable by up to 50% in both directions (increases and decreases). The center point represents the current cost for a gasoline vehicle and movement to the left or right indicates an increase or decrease in the overall cost caused by changing the variable.

We see that fuel prices have a significant impact on the overall cost of the vehicle, and that decreasing the fuel economy of a vehicle by 50% has a large impact on the total cost of owning that vehicle. We also see that the cost of carbon has a less significant impact on the total cost of ownership than the other variables.